# COHERENT RANDOM ACCESS CHANNEL IN A SPREAD-SPECTRUM COMMUNICATION SYSTEM AND METHOD

## RELATED INVENTIONS

The present invention is related to the following inventions which are assigned to the assignee of the present invention:

Method And Apparatus For Coherent Communication In A Spread-Spectrum Communication System by Fuyun Ling having U.S. Ser. No. 08/031,258, and filed on Mar. 11, 1991, now U.S. Pat. No. 5,329,547 which was issued on Jul. 12, 1994.

Method And Apparatus For Providing High Data Rate Traffic Channels In A Spread Spectrum Communication System by Gene Bruckert et al. having U.S. Ser. No. 07/669,127, and filed on Mar. 13, 1991, now U.S. Pat. No. 5,204,876 which was issued on Apr. 20, 1993.

Method And Apparatus For Accommodating A Variable Number Of Communication Channels In A Spread Spectrum Communication System by Gene Bruckert et al. having U.S. Ser. No. 07/669,134, and filed on Mar. 13, 1991, now U.S. Pat. No. 5,235,614 which was issued on Aug. 10, 1993.

## FIELD OF THE INVENTION

The present invention relates to communication systems which employ spread-spectrum signals and, more particularly, to a method and apparatus for a coherent random access channel in a spread-spectrum communication system.

## BACKGROUND OF THE INVENTION

Communication systems take many forms. In general, the purpose of a communication system is to transmit information-bearing signals from a source, located at one point, to a user destination, located at another point some distance away. A communication system generally consists of three basic components: transmitter, channel, and receiver. The transmitter has the function of processing the message signal into a form suitable for transmission over the channel. This processing of the message signal is referred to as modulation. The function of the channel is to provide a physical connection between the transmitter output and the receiver input. The function of the receiver is to process the received signal so as to produce an estimate of the original message signal. This processing of the received signal is referred to as demodulation.

One type of communication system is a multiple access spread-spectrum system. In a spread-spectrum system, a modulation technique is utilized in which a transmitted signal is spread over a wide frequency band within the communication channel. The frequency band is much wider than the minimum bandwidth required to transmit the information being sent. A voice signal, for example, can be sent with amplitude modulation (AM) in a bandwidth only twice that of the information itself. Other forms of modulation, such as low deviation frequency modulation (FM) or single sideband AM, also permit information to be transmitted in a bandwidth comparable to the bandwidth of the information itself. However, in a spread-spectrum system, the modulation of a signal to be transmitted often includes taking a baseband signal (e.g., a voice channel) with a bandwidth of only a few kilohertz, and distributing the signal to be transmitted over a frequency band that may be many megahertz wide. This is accomplished by modulating the signal to be transmitted with the information to be sent and with a wideband encoding signal.



Three general types of spread-spectrum communication techniques exist, including direct sequence modulation, frequency and/or time hopping modulation, and chirp modulation. In direct sequence modulation, a carrier signal is modulated by a digital code sequence whose bit rate is much higher than the information signal bandwidth.

Information (i.e. the message signal consisting of voice and/or data) can be embedded in the direct sequence spread-spectrum signal by several methods. One method is to add the information to the spreading code before it is used for spreading modulation. It will be noted that the information being sent must be in a digital form prior to adding it to the spreading code, because the combination of the spreading code and the information typically a binary code involves modulo-2 addition. Alternatively, the information or message signal may be used to modulate a carrier before spreading it.

These direct sequence spread-spectrum communication systems can readily be designed as multiple access communication systems. For example, a spread-spectrum system may be designed as a direct sequence code division multiple access (DS-CDMA) system. In a DS-CDMA system, communication between two communication units is accomplished by spreading each transmitted signal over the frequency band of the communication channel with a unique user spreading code. As a result, transmitted signals are in the same frequency band of the communication channel and are separated only by unique user spreading codes. These unique user spreading codes preferably are orthogonal to one another such that the cross-correlation between the spreading codes is approximately zero.

Particular transmitted signals can be retrieved from the communication channel by despreading a signal representative of the sum of signals in the communication channel with a user spreading code related to the particular transmitted signal which is to be retrieved from the communication channel. Further, when the user spreading codes are orthogonal to one another, the received signal can be correlated with a particular user spreading code such that only the desired user signal related to the particular spreading code is enhanced while the other signals for all of the other users are not enhanced.

It will be appreciated by those skilled in the art that several different spreading codes exist which can be used to separate data signals from one another in a DS-CDMA communication system. These spreading codes include but are not limited to pseudonoise (PN) codes and Walsh codes. A Walsh code corresponds to a single row or column of the Hadamard matrix.

Further it will be appreciated by those skilled in the art that spreading codes can be used to channel code data signals. The data signals are channel coded to improve performance of the communication system by enabling transmitted signals to better withstand the effects of various channel impairments, such as noise, fading, and jamming. Typically, channel coding reduces the probability of bit error, and/or reduces the required signal to noise ratio usually expressed as error bits per noise density (i.e., $E_b/N_0$ which is defined as the ratio of energy per information-bit to noise-spectral density), to recover the signal at the cost of expending more bandwidth than would otherwise be necessary to transmit the data signal. For example, Walsh codes can be used to channel code a data signal prior to modulation